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POSTLARVAL *SUDIS* (PISCES: PARALEPIDIDAE) IN THE ATLANTIC OCEAN*

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ABSTRACT. The paralepidids, *Sudis atrox Rofen* 1963 and *Sudis hyalina* Rafinesque 1810, are present in midwater collections from the Atlantic Ocean. Postlarval development is described and illustrated with particular attention given to head spination. This character is similarly developed in both species, but it differs in form and degree of head coverage (more extensive in *S. atrox*) providing a basis for species differentiation.

INTRODUCTION

The WHOI midwater trawl collections (Fig. 1) contain numerous postlarval paralepidids referable to the genus *Sudis*. Examination of these shows that two species are represented. One, *Sudis hyalina* Rafinesque 1810, has been known only from the North Atlantic and the Mediterranean. The other, referable to *Sudis atrox* Rofen 1963, has been known only from the North Pacific. This note describes the postlarval development of *S. atrox*, compares this development with that of *S. hyalina*, and records the Atlantic distribution of these species.

STUDY MATERIAL

The study material consists of 132 specimens of *S. atrox* and 32 specimens of *S. hyalina*. Collection data is shown in Tables 1 and 2 with the distribution of catches plotted in Figure 1. The specimens were caught by midwater trawls with no opening-closing mechanism. The majority of the specimens (153 out of 164) came from tows shallower than 250 meters and show that the two species can be expected in any collection at this depth or shallower.

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Accordingly, the "no catch" records in Figure 1 (squares) show the distribution of tows that were at appropriate depths for catching the two species but which nevertheless took no specimens. Figure 1 shows that *S. hyalina* is a northern species and *S. atrox* is a tropical one, with the two occurring together in the Gulf of Mexico. *S. hyalina* has also been found in our collections from off the Rio de la Plata (ca. 32°S) and thus a biantitropical distribution is suggested. The two specimens of *S. atrox* collected near 38°N, 67°W are probably Gulf Stream waifs.

Sudis atrox was described by Rofen (1963) from a 75 mm SL Pacific Ocean specimen taken from the stomach of *Alepisaurus*

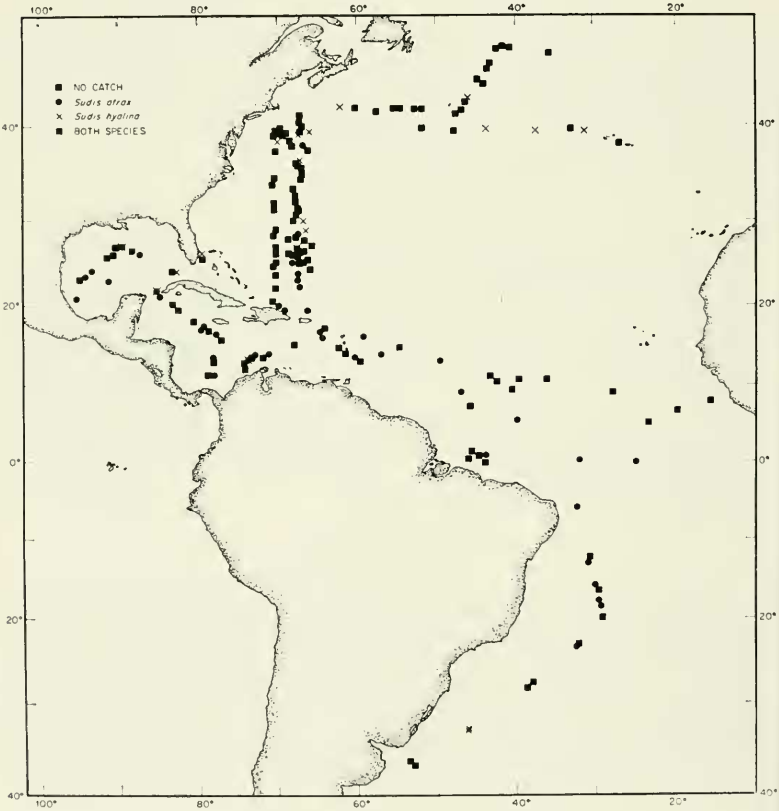

Figure 1. Atlantic distribution of *Sudis atrox* Rofen and *Sudis hyalina* Rafinesque, based on captures listed in Tables 1 and 2. "No catch" records are all trawls shallower than 250 m that did not take specimens.

caught on longline gear at 29°26′N, 134°59′W. Pacific postlarval specimens were reported by Berry and Perkins (1966) with a drawing of a 21.5 mm SL specimen. The adult specimens of the two species differ by vertebral counts (59-60 for *S. hyalina* vs. 53-54 for *S. atrox*) and by the number of lateral line pores (four to seven per each lateral line section for *S. hyalina* and three for *S. atrox*) (Rofen, 1966). My specimens have been identified by vertebral counts obtained from X-rays of representative specimens (60-61 vertebrae for five *S. hyalina* and 52-54 for 15 *S. atrox*) and by the postlarval characters of pigment patterns, degree and type of spination, and pectoral fin length.

DEVELOPMENTAL CHARACTERS

SUDIS ATROX

The development of *S. atrox* closely resembles that of its congener, *S. hyalina.* The pectoral fins are long and spines are present on the head. The *S. atrox* head spination is so extensive in development and unique in form that it can be used to identify postlarval specimens. The spines are located on the head as follows:

Preoperculum. Large, obvious spine at the posteroventral angle, with serrated edges and hooked processes along its length. Two large processes at its base, one directed posterodorsally and the other ventrally. Ventral and posterior edges of the preoperculum with spine-tipped scalloped flanges. Ventral flange obvious; posterior one small and inconspicuous.

Dorsal surface of head. Two spine-tipped scalloped flanges above eye, a shorter one directed laterally and a longer one directed dorsally. Paired spine-tipped scalloped flanges medial to supraocular flanges on dorsal surface of head from tip of snout posteriorly to a line between anterior margins of orbits.

Mandible. Spine-tipped scalloped flange along side of lower jaw.

Shoulder. Two spines.

These spiny processes are observed in the smallest specimen (5.5 mm SL) and are most extensively developed in the 10 to 20 mm specimens. They are worn down and indistinct in specimens larger than 30 mm (Table 3).

The development of *Sudis atrox* is also distinguished by six peritoneal sections, by the late development of the elongated pectoral fin, and by the early development of widespread trunk pigment.

5.5 mm SL (Fig. 2A). Head deep, top involuted with a ridge on each side. Ridge with a conspicuous spine-tipped scalloped flange. Spiny flange along ventral edge of preoperculum and three relatively large spines at the posteroventral preopercular angle. The middle one of these three spines, which points posteroventrally, is truncated. It is apparently broken off; another specimen of approximately the same size (6.0 mm SL RHB 1717) has this middle spine longer and stouter than the other two with an

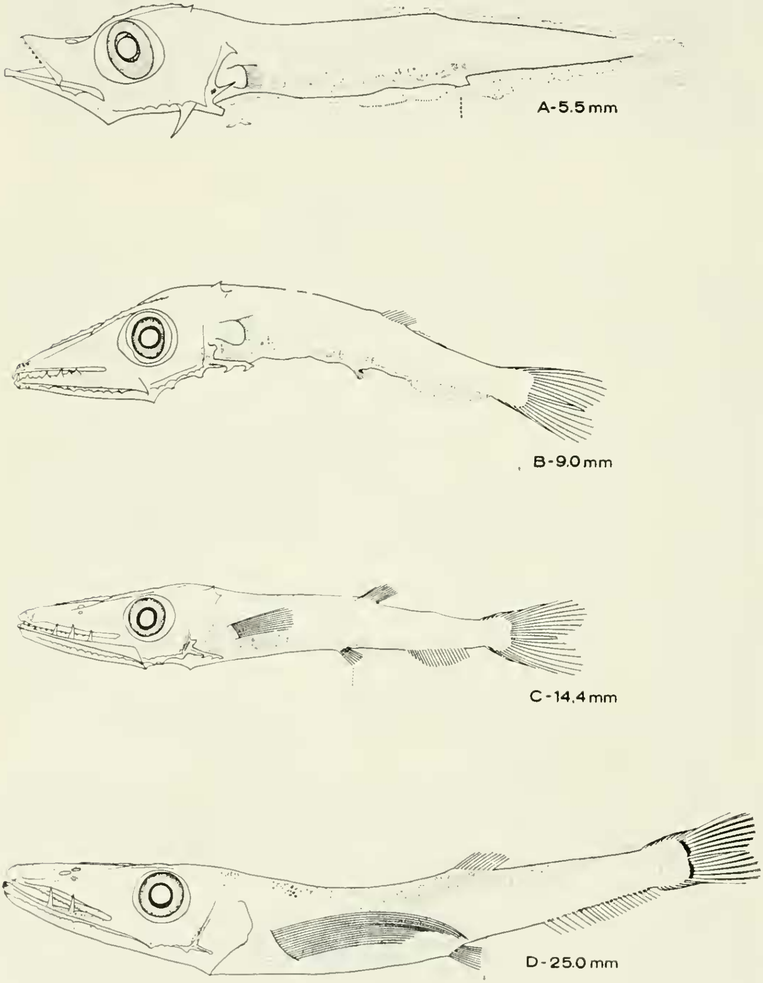

Figure 2. Postlarval stages of *Sudis atrox* Rofen. A. RHB 1107. B. RHB 1291. C. RHB 1108. D. RHB 1294. Drawn by Martha Howbert.

antrorse hook ventrally located near the spine tip (shown in Fig. 2A in broken line). Eye compressed, obliquely oriented. Pectoral fin rounded, short, on short stalked base; rays evident. Dorsal and anal fin bases barely discernible in embryonic finfold. Peritoneal pigment extending two-thirds length of trunk from pectoral base to a point over anterior section of rudimentary anal fin. Anterior half of this pigment diffuse; posterior half partitioned into three sections. Dense cluster of small pigment cells on base of preoperculum angle spine.

9.0 mm SL (Fig. 2B). Head deep, massive, flat on top, sharply angular between top and sides. Snout length and head length relatively longer than in 5.5 mm specimen (50.0% vs. 38.0% for snout length and 46.6% vs. 32.0% for head length). Four canine teeth on lower jaw. Head studded with spine-tipped scalloped flanges that are well developed along top of snout, over eye (two flanges here — one directed laterally and one directed dorsally), along lower jaw, and on preoperculum ventral edge. Also a large spine extending back from posteroventral angle of preoperculum, with serrated upper and lower edges and two prominent antrorse hooks (Fig. 4A). This spine has a triangular cross section large at base and decreasing in size out to tip, with the two antrorse hooks stemming from laterally directed apex or 'keel' of this triangular cross section.

Fins well formed with interspinous rays. Pectoral fins short, extending only one third of distance to ventral fin base. Six well formed peritoneal sections going back to anal fin origin. Pigment patches at jaw tips, scattered cells on lower jaw, small ones on preoperculum posterior margin and two large stellate chromatophores on base of preopercular angle spine. Large chromatophores spread evenly over cerebral hemispheres, one of the same over hind brain, and several between the two brain sections.

14.4 mm SL (Fig. 2C). Head form as in 9.0 mm specimen. Three canines on left side and four on right. Pectoral fins reaching halfway to ventral bases. Dorsal and anal fins with 10 and 20 rays, respectively. Spines about head as in 9.0 mm specimen, excepting more spine tips in the flanges (Table 3) and two obvious spines added to preoperculum ventral edge, apart from spiny flange already described for that area. Spine deterioration indicated in dorsally directed supraocular flange in which spine tips are relatively blunt. Spine deterioration suggested in preopercular angle spine in which the hooks are smaller in relation to the total size of this spine than is observed in 9.0 mm specimen.

Pigment about head as in 9.0 mm specimen, excepting thicker coverage of large chromatophores over brain, with dense arc of same over anterior edges of cerebral hemispheres. Trunk with broad grouping of large stellate chromatophores on dorsum between nape and dorsal fin origin, patch of chromatophores at dorsal origin, and grouping of three pigment cells over hypural plate. Six peritoneal sections.

25.0 mm SL (Fig. 2D). General body form essentially as before with large deep head on relatively short body. Three canines left and four right. Pectoral fins long, reaching beyond ventral bases; 15 rays. Pigment cells proximally and medially on rays 1 and 2; patches medially and distally on rays 3-7. Other fin ray counts: Dorsal — 10; Anal — 21; Ventrals — 9.

Head spination not apparent. Spines in scalloped flanges fewer (Table 3). Spines, when present, worn down as in supraocular flanges, where eight spines in lateral flange and thirteen spines in dorsal flange are reduced to rounded irregularities in what appear to be only eroded or broken ridges over eye.

Body pigment extensive, evenly spread on dorsum and sides of same spread over hypural plate. Anterior portion of lateral line ventrally edged with small pigment cells. (Lateral line not pigmented.) Fin bases with varying degrees of pigmentation: large light chromatophores on roots of dorsal and anal fins; small dark cells at base of ventral rays; and large, moderately dark pigment cells forming vertical line at base of caudal fin. Six peritoneal sections.

38.0 mm SL (Not figured; RHB 1281). Head and body essentially as before. Head deep, massive. Four canines. Pectoral fin broken off; 15 rays. Dorsal — 12 rays; Anal — 21 rays; Ventrals — 9 rays. Vestiges of post larval spination present but very small and obscure. Primary character is trunk pigment, which is denser and slightly more extensive than in 25.0 mm specimen. Lower margin of lateral line pigmented for entire length (no pigment over lateral line). Vertical bar at caudal base darker, more apparent. Six peritoneal sections.

SUDIS HYALINA

The development of *S. hyalina* closely parallels that of *S. atrox*. The body form is essentially the same, with a relatively short body and a large head. Spines are present over the eye and on the preoperculum lower margin.

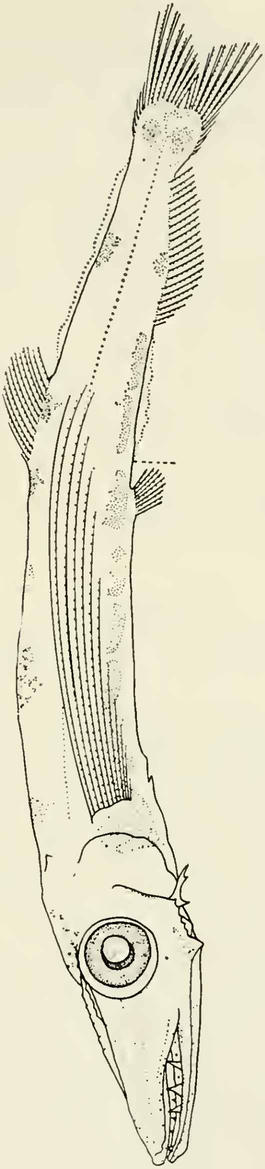

Figure 3. Postlarval *Sudis hyalina* Rafinesque, 16.1 mm SL, RHB 1307. Drawn by Martha Howbert.

16.1 mm SL (Fig. 3). Head large (31.6% of SL) but not as deep and massive as in *S. atrox*. Trunk short but not as deep and stout appearing as in *S. atrox*. Pectoral fin very long, extending beyond ventral bases and anus; small pigment cells near bases of first five rays, larger blotchy cells further out on rays 2-7.

Spination includes eight spine tips on scalloped flange over eye, six very small spine tips on posterior half of flange running length of snout, five spine tips on scalloped flange along preoperculum ventral edge, and a relatively large spine extending posteriorly from posteroventral angle of preoperculum (Fig. 4B). This latter spine has a retrorse hook distally (giving spine a bifurcated appearance) and a second larger retrorse hook at base.

Trunk pigment concentrated in patches, with six patches on dorsum (three anterior to dorsal fin, one at dorsal origin, one at dorsal base, and one posterior to dorsal base), one patch midway on anal fin base, and two over hypural plate above and below notochord. Eight peritoneal sections. Large stellate chromatophores over brain. Small pigment cells on jaws and margins of preoperculum.

COMPARISON

The distinctive characters of *S. atrox* are pointed out with reference to *S. hyalina*.

1. *Spination*. Spine-tipped flanges present on both *S. atrox* and *S. hyalina* on preoperculum ventral edge, over eye, and along posterior part of snout. Additional distinctive spines present on *S. atrox* along lower jaw, anterior part of snout flange, and in a second spiny flange over eye. The large spine at preopercular angle in *S. atrox* is distinctive for its serrated edges and one or more antrorse hooks, whereas this spine in *S. hyalina* is smooth with only one retrorse hook (Fig. 4).

2. *Pectoral fin*. Short in early postlarval *S. atrox*, reaching ventral origin in three specimens at 16.5 mm (RHB 1289), 17.3 mm (RHB 1297), and 19.5 mm (RHB 1281). In contrast, the pectoral fin of *S. hyalina* is long, very early in development reaching ventral origin in an 8.0 mm specimen (RHB 1043) and extending beyond ventral base and anus in a 9.0 mm specimen (RHB 1047).

3. *Pigment*. Six peritoneal sections in *S. atrox* vs. seven to eight in *S. hyalina*. Trunk pigment in *S. atrox* evenly spread over trunk surface vs. patch pattern distribution in *S. hyalina*. 14.4 mm *S. atrox* (described in text) — pigment grouping covering middle

half of nape to dorsal fin area, plus pigment patch at dorsal fin origin and three small chromatophores over hypural plate. 16.0 mm *S. atrox* (RHB 1277) — uniform coverage of dorsum back to point halfway between dorsal fin and procurrent caudal rays

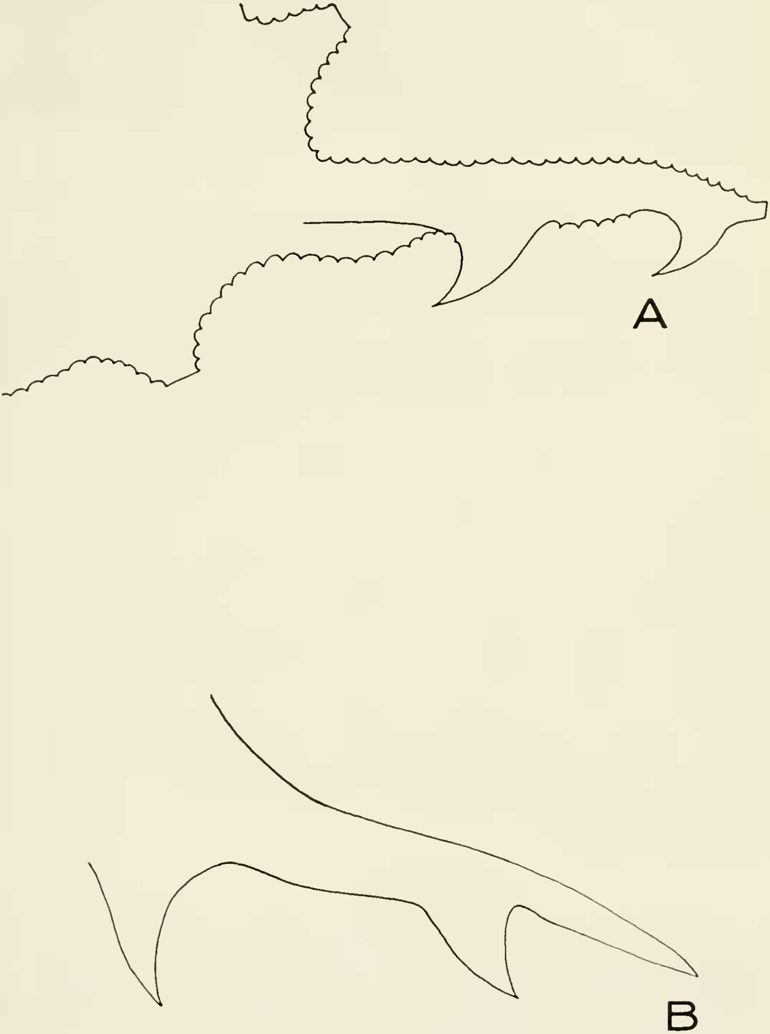

Figure 4. Preopercular spines. A. *Sudis atrox* Rofen, 9.0 mm SL, RHB 1291. B. *Sudis hyalina* Rafinesque, 16.1 mm SL, RHB 1307. Drawn by Martha Howbert.

plus hypural pigment. 19.5 mm *S. atrox* (RHB 1281) — even coverage of dorsum back to procurrent caudal rays all but connected to and continuous with hypural pigment. (See also pigment coverage in 25.0 mm *S. atrox,* Fig. 2D.) In contrast, *S. hyalina* trunk pigment concentrated in nine patches in specimens from 16.1 mm SL (See specimen described and figured above.) to 36 mm SL. Patches clearly defined in 28 mm specimen (RHB 1307), spread out but still recognizable in 33 mm specimen (RHB 1439), and all but blended into uniform coverage in 36 mm specimen (RHB 1313).

RELATION OF *SUDIS* TO MAN

Bites on polypropylene mooring cables serious enough to sever the individual fibers have been reported off Bermuda and were connected with fish through tooth fragments left on the cable (Turner and Prindle, 1965). *Sudis hyalina* has been identified as the fish responsible for certain bites in depths of 600 to 800 meters (Haedrich, 1965). The bites have occurred in pairs on one side of the cable only and presumably have been made by the long canine teeth on either side of the lower jaw. The distance between cuts of a pair range from 30 to 60 mm. Reference to the tooth arrangement of a 405 mm *S. hyalina* with an 18 mm distance between dentaries places the size of the cable-biting *Sudis* at more than a meter in length. These bites might just as well have been caused by *S. atrox* as by *S. hyalina.* The mandibular canine teeth of both species are long and strong. The fragments in the rope have serrated edges matching the teeth of adult *S. hyalina.* The teeth of the 75 mm juvenile holotype of *S. atrox* have smooth edges (Rofen, 1963) as does a 75 mm specimen of *S. hyalina* (Rofen, 1966). Until teeth of larger specimens of *S. atrox* are obtained, the question of the origin of the bites described by Haedrich (1965) remains unanswered.

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TABLE 1 — STUDY MATERIAL

Sudis atrox Rofen, 1963

Coll. No.	*No. of Specs.*	*Size Range (SL) (mm)*	*Position*		*Date*	*Max. Depth (m)*
581	1	8	19°21′N,	66°20′W	2 Mar. 54	90
962	1	12	5°24′N,	39°55′W	13 Feb. 63	860
967	1	8	0°26′N,	32°06′W	18 Feb. 63	60
972	3	20-21	0°03′N,	25°00′W	23 Feb. 63	87
981	1	9	5°42′S,	32°25′W	1 Mar. 63	120
1101	2	25-38	13°18′N,	60°05′W	13 June 65	187
1105	1	15	15°42′N,	64°13′W	14 June 65	230
1107	4	6-12	19°52′N,	69°46′W	16 June 65	140
1108	1	14	19°55′N,	70°04′W	16 June 65	525
1200	1	14	16°13′N,	59°09′W	11 Feb. 66	450
1202	4	10-11	13°00′N,	49°38′W	14 Feb. 66	220
1216	1	9	1°12′N,	44°39′W	11 Apr. 66	410
1218	1	21	9°12′N,	47°03′W	16 Apr. 66	360
1222	2	8-22	13°55′N,	57°00′W	30 Apr. 66	300
1253	4	10-17	16°38′N,	64°27′W	25 May 66	133
1258	2	28-35	13°32′N,	71°24′W	27 May 66	210
1261	1	24	13°04′N,	73°12′W	28 May 66	300
1263	3	14-43	12°58′N,	73°34′W	29 May 66	120
1274	8	8-12	13°07′N,	78°23′W	5 June 66	109
1277	21	10-17	16°12′N,	78°00′W	6 June 66	198
1281	2	20-38	17°08′N,	79°35′W	6 June 66	205
1282	5	11-18	17°07′N,	79°32′W	7 June 66	185
1289	4	17-35	21°11′N,	85°12′W	10 June 66	170
1290	2	12-15	21°17′N,	85°22′W	11 June 66	124
1291	2	9-12	22°54′N,	91°36′W	12 June 66	57
1294	3	15-25	20°48′N,	95°48′W	17 June 66	100
1297	13	15-33	23°13′N,	94°50′W	19 June 66	128
1298	3	19-22	23°55′N,	94°00′W	19 June 66	370
1307	1	13	27°01′N,	90°02′W	22 June 66	95
1310	1	14	26°12′N,	87°54′W	23 June 66	2150*
1423	1	29	12°21′S,	31°04′W	1 Mar. 67	90
1425	3	5-10	16°07′S,	29°59′W	3 Mar. 67	85
1427	2	15-18	18°10′S,	29°40′W	5 Mar. 67	140
1428	4	6-8	18°21′S,	29°39′W	5 Mar. 67	75
1432	2	10-11	23°08′S,	32°22′W	9 Mar. 67	110
1505	2	10-10	37°40′N,	66°50′W	25 Aug. 67	105
1713	6	8-11	25°06′N,	67°45′W	1 Dec. 68	125
1716	1	15	23°24′N,	67°30′W	1 Dec. 68	140
1717	6	6-10	23°00′N,	67°29′W	2 Dec. 68	30
1718	3	6-28	22°51′N,	67°30′W	2 Dec. 68	210

1727	1	12	26°46′N,	67°32′W	6 Dec. 68	65
1736	1	13	28°35′N,	67°24′W	8 Dec. 68	87
R/V *'Anton Bruun'* Cr. 19						
Sta. 813	1	45	11°06′N,	78°21′W	7 Aug. 66	2250*

*Oblique tow

The specimens in collections 1107 and 1108 were the first Atlantic specimens of *S. atrox* to be reported (Backus et al., 1969).

TABLE 2 — STUDY MATERIAL

Sudis hyalina Rafinesque, 1810

Coll. No.	*No. of Specs.*	*Size Range (SL) (mm)*	*Position*		*Date*	*Max. Depth (m)*
861	1	28	41°40′N,	61°57′W	15 Sept. 62	64
866	1	11	39°20′N,	66°45′W	18 Sept. 62	68
867	2	17-20	39°03′N,	67°18′W	19 Sept. 62	110
1022	1	16	42°35′N,	45°56′W	10 Sept. 64	50
1043	1	8	39°28′N,	31°00′W	25 Sept. 64	35
1047	1	9	39°25′N,	36°56′W	27 Sept. 64	52
1050	1	11	39°31′N,	43°33′W	29 Sept. 64	53
1263	1	16	12°58′N,	73°34′W	29 May 66	120
1290	2	13-14	21°17′N,	85°22′W	11 June 66	124
1307	10	16-48	27°01′N,	90°02′W	22 June 66	95
1313	1	36	23°55′N,	83°12′W	25 June 66	145
1315	1	12	25°46′N,	79°47′W	26 June 66	71
1438	1	30	32°53′S,	46°06′W	16 Mar. 67	110
1439	2	21-33	32°56′S,	46°12′W	16 Mar. 67	40
1508	1	34	36°27′N,	67°18′W	26 Aug. 67	190
1706	1	13	30°10′N,	67°32′W	28 Nov. 68	217
1727	1	7	26°46′N,	67°32′W	6 Dec. 68	65
1737	1	14	28°45′N,	67°26′W	8 Dec. 68	135
'Captain Bill III', Cr. 65-1						
Sta. MWT-1	2	14-18	38°11′N,	69°47′W	11 May 65	90

TABLE 3

Spine development and deterioration; spine counts in postlarval stages of *Sudis atrox*.

Standard Length (SL) (mm)	*Preoperculum*			*Supraocular*		*Snout*	*Lower Jaw*
	Posteroventral Angle	*Ventral Edge*	*Posterior Edge*	*Laterally Directed*	*Dorsally Directed*		
5.5	3 Long Spines	5	1	—	6	—	2
9.0	Keeled, serrated spine with 2 hooks, 2 basal processes	6	5	3	11	9	9
14.4	Keeled, serrated spine with 3 hooks (and base of 4th), 2 basal processes	8	5	9	13	11	13
25.0	Spine relatively small, serrations irregular, stubby bases of 2 hooks, general deterioration	2	3	8 Worn down spine bases	13 Worn down spine bases	5 Worn down spine bases	12 Blunt spines
38.0	Spine worn down, all but absorbed	—	—	Eroded, irregular flange, no spines		—	Flange with no spines